Spectral and statistical analysis of the far-field and near-field records of the 1960 Chile tsunami

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Abstract. The Chile Tsunami of 24 May 1960 was one of the most dangerous and destructive marine natural hazards in the 20th century. Extraordinarily high waves were observed along coasts throughout the Pacific Ocean. Numerous towns, villages, ports, and harbors of South and North America, Asia, and Australia were severely damaged. The 1960 Chile Tsunami was recorded by a great many tide gauges installed in very different places along the coast of the Pacific Ocean. Spectral and statistical analyses of these records and an examination of their changes with time and space is of high scientific and applied interest. The main purpose of the present study was to compare characteristics of the far-field and near-field tsunami records. So we used the records from several Russian (Petropavlovsk, Rybachy, Yuzhno-Kurilsk, Korsakov, Katangli, Poronaisk, and Kholmsk) and Japanese (Hanasaki, Hakodate, and Kamaishi) stations located at approximately 15,000 km from the source area, as well as the Chilean stations (Arica, Antofagasta, Coquimbo, and Valparaiso) situated very close to the tsunami source. We estimated temporal variability and energy decay of tsunami waves, we also constructed time-frequency spectral diagrams to examine and compare wave structure of the tsunami signal at nearby and distant stations. We found that the tsunami energy at stations on the South American coast remained quite high for a period longer than a week, apparently because of trapping effects and the conservation of wave energy on the shelf. The tsunami intensity on this shelf varied with a period of about 1 day, probably due to reflection from the shelf margins. As a result, maximum tsunami wave heights occurred a few hours after the first wave arrival. Tsunami behavior at the distant stations located on the opposite coast of the Pacific was quite different; leading waves had maximum wave heights, and the intensity of tsunami waves at almost all stations (except Kamaishi) decayed quite rapidly. The method proposed by Rabinovich (1997) was used to separate source and topographic effects in the tsunami spectra. The results of the source reconstruction based on analysis of various Chilean stations were in good agreement, demonstrating that the main energy in the source area was contained in the 20–60 min period band, with a peak value at 45 min. Spectral estimates based on analysis of the far-field stations (Russian and Japanese) were less stable and, in general, the corresponding spectra were more "reddish" (low-frequency), with the energy concentrated primarily in the 60–100 min period band.

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